

Exhibit 11





Hardware RAM

DDR6 RAM: The Next Big Thing in Memory Technology



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DDR6 RAM: If you are a computer enthusiast, you might have heard of DDR6 RAM, the next generation of memory technology for computers and graphics cards. But what is DDR6 RAM and how does it work? What are the benefits of this RAM over DDR4 and DDR5 RAM? When will DDR6 RAM be released and how much will it cost? How to upgrade to this RAM and what do you need to know? And most importantly, is worth the wait?

In this article, we will explore these questions and more, using a list of semantic keywords to guide our discussion and provide relevant information. We will also use another list of words that are related to DDR6 RAM and its features. We hope that by the end of this article, you will have a better understanding of DDR6 RAM and its potential

impact on the future of memory technology. Check out the [How to Find Inner Peace in a Tech-Driven World: 7 Practical Tips](#) 😊💨.

Table of contents

- [What is DDR6 RAM and How Does It Work?](#)
- [What are the Benefits of DDR6 RAM over DDR4 and DDR5 RAM?](#)
- [What is JEDEC and How Does It Define the Standards for DDR6 RAM?](#)
- [When Will DDR6 RAM Be Released and How Much Will It Cost?](#)
- [How to Upgrade to DDR6 RAM and What You Need to Know](#)
- [Conclusion: Is DDR6 RAM Worth the Wait?](#)

What is DDR6 RAM and How Does It Work?

DDR6 RAM stands for Double Data Rate 6 Random Access Memory. It is a type of memory that stores data temporarily and allows fast access to it. RAM is used by the CPU (Central Processing Unit) to perform calculations and run programs. The faster the RAM, the faster the CPU can process data.

DDR6 RAM is the successor of DDR5 RAM, which is currently the standard memory type for most computers and graphics cards. This RAM is expected to offer faster speeds, higher bandwidth, lower power consumption, and improved reliability compared to DDR5 RAM.

DDR6 RAM works by using a technique called MSAP (Multi-Sided Asymmetric Package). This technique allows the memory chips to be

stacked on both sides of the module, increasing the density and capacity of the memory. MSAP also reduces the distance between the memory chips and the controller, improving the signal integrity and reducing the latency.

This RAM also uses a technique called PAM4 (Pulse Amplitude Modulation 4). This technique allows the memory to send four bits of data per clock cycle, instead of two bits as in previous generations of DDR memory. PAM4 doubles the data rate and bandwidth of the memory, without increasing the clock speed or power consumption. Check out [What is the Fastest SSD](#).

What are the Benefits of DDR6 RAM over DDR4 and DDR5 RAM?

DDR6 RAM offers several benefits over DDR4 and DDR5 RAM, such as:

FEATURE	DDR4	DDR5	DDR6
Data rate (MT/s)	1600 – 3200	3200 – 6400	4800 – 8400
Voltage (V)	1.2	1.1	1.05
Capacity (Gb per chip)	4 – 16	8 – 64	16 – 128
Bus width (bits per channel)	64	32 x 2	16 x 4
Error correction	Optional ECC	On-die ECC and CRC	On-die FEC and CRC
Signal modulation	NRZ (2-level)	NRZ (2-level)	PAM4 (4-level)
Package technology	TSV or PoP	TSV or PoP	MSAP

Faster Speeds and Higher Bandwidth

DDR6 RAM can achieve data rates of up to 24 Gbps per pin, which is 30% faster than DDR5 RAM (18 Gbps) and 60% faster than DDR4 RAM (15 Gbps). This means that DDR6 can transfer more data in less time, resulting in smoother performance and faster loading times.

Check out the [ddr4 vs ddr5](#) Article.

This RAM can also support a maximum bandwidth of over 1 TB/s with a 384-bit bus width. This means that DDR6 can handle more data simultaneously, resulting in higher resolution and frame rates for graphics applications.

Lower Power Consumption and Heat Generation

DDR six RAM can operate at a lower voltage of 1.35 V, which reduces power consumption and heat generation. This can extend the battery life of laptops and mobile devices, as well as improve the stability and longevity of desktops and graphics cards.

DDR six RAM also uses a technique called DFE (Decision Feedback Equalization). This technique reduces the noise and interference in the signal, improving the quality and efficiency of the data transmission. DFE also reduces the power consumption and heat generation of the memory.

Better Reliability and Error Correction

DDR6 RAM can use advanced error correction techniques, such as FEC (Forward Error Correction) and CRC (Cyclic Redundancy Check). These techniques detect and correct data errors, enhancing the reliability and quality of the data output. These techniques are especially useful in high-resolution and high-refresh-rate scenarios, where data errors can cause visual artifacts or glitches.

What is JEDEC and How Does It Define the Standards for DDR6 RAM?

JEDEC stands for Joint Electron Device Engineering Council. It is an independent semiconductor engineering trade organization and standardization body. JEDEC develops and publishes the standards for memory technologies, including DDR6 RAM.

The History and Role of JEDEC

JEDEC was founded in 1958 as a joint committee of several electronic industry associations. Its original purpose was to coordinate the development of transistors and diodes. Over time, JEDEC expanded its scope to include other types of electronic devices, such as integrated circuits, microprocessors, flash memory, solid state drives, etc.

JEDEC's role is to provide technical specifications, test methods, quality standards, design guidelines, etc., for various electronic devices. JEDEC also facilitates communication and collaboration among its members, which include over 300 companies from around the world. JEDEC's standards are widely adopted and recognized by the industry and the consumers.

The Technical Specifications of DDR6 RAM by JEDEC

JEDEC has been working on the standards for DDR6 RAM since 2018. In 2020, JEDEC published the first official specification for DDR six RAM, called JESD79-6. This specification defines the key features and parameters of DDR6 RAM, such as:

- Data rate: 16 to 24 Gbps per pin
- Voltage: 1.35 V
- Capacity: 8 to 32 Gb per chip
- Bus width: 8 to 16 bits per channel
- Memory channels: 1 to 4 per module
- Module types: UDIMM, SODIMM, RDIMM, LRDIMM, etc.
- Error correction: FEC and CRC
- Signal modulation: PAM4
- Package technology: MSAP

JEDEC is also working on the standards for DDR6 NVDIMM (Non-Volatile Dual In-line Memory Module), which is a type of memory that combines DDR6 RAM with flash memory. DDR six NVDIMM can provide persistent storage and backup power for critical data.

The Challenges and Opportunities of Developing DDR6 RAM by JEDEC

Developing DDR6 RAM poses several challenges and opportunities for JEDEC and its members. Some of the challenges are:

- Achieving higher data rates and bandwidth without compromising signal integrity and power efficiency
- Developing new package technologies and materials to enable higher density and capacity
- Implementing new error correction techniques and protocols to ensure reliability and quality
- Testing and validating the performance and compatibility of DDR6 RAM with various devices and applications

Some of the opportunities are:

- Providing faster and more efficient memory solutions for emerging markets and applications, such as cloud computing, artificial intelligence, big data, gaming, etc.
- Enhancing the user experience and satisfaction with smoother performance and faster loading times
- Reducing the environmental impact and cost of memory production and consumption with lower power consumption and heat generation
- Driving innovation and competition in the memory industry with new features and standards

When Will DDR6 RAM Be Released and How Much Will It Cost?

DDR6 RAM is still in development, and it is expected to be commercially available in 2026, according to Samsung, one of the main producers of memory modules.

Development and Testing Status

Samsung announced in 2020 that it had successfully developed the world's first DDR6 RAM module with a data rate of 24 Gbps per pin. Samsung also claimed that it had achieved a bandwidth of over 1 TB/s with a 384-bit bus width. Samsung said that it would start mass production of DDR six RAM in 2022.

Other memory manufacturers, such as SK Hynix, Micron, Nanya, etc., are also developing their own versions of DDR6 RAM. They are expected to follow Samsung's lead and start mass production in 2022 or later.

JEDEC is also continuing to update and refine the standards for DDR6 RAM. JEDEC is expected to publish more specifications and guidelines for DDR six RAM in the coming years.

Expected Release Date and Availability

DDR6 RAM is expected to be released in 2026, according to Samsung. However, this does not mean that DDR six RAM will be widely available or affordable at that time. It may take several years for DDR6 RAM to become mainstream and replace DDR5 RAM as the standard memory type for most devices.

The availability and adoption of DDR6 RAM will depend on several factors, such as: